Evaluation of competences in critical reading and scientific thinking mathematics and statistics in the Saber 11 and Saber Pro 2016-2017 tests in two engineering programs

Evaluación de competencias en lectura crítica y pensamiento científico en matemáticas y estadística en las pruebas Saber 11 y Saber Pro 2016-2017 en dos programas de ingeniería

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Abstract

The objective of this work is to evaluate the competences in critical reading and scientific mathematical and statistical thinking of students in the last semester of Financial Engineering and Commercial Engineering. In this context, the evaluation is considered as learning guiding process, through it, it is possible to obtain the necessary information to identify what was learned, what was not learned and take assertive decisions can be made in the teaching process and learning. Therefore, in this research, the results achieved by the students in the Saber 11 Tests applied by ICFES, and subsequently, the results obtained by the same students in the Saber Pro Tests, belonging to the programs in mention of the Universidad Libre.

This research is a study of evaluative design, non-experimental, of explanatory character that uses a methodology of complementarity between the qualitative and quantitative methods. The SPSS software was used as an instrument for data processing, through which the results generated in the Saber 11 Test and Saber Pro Test were evaluated. The sample was census in nature, made up of 187 university students belonging to the two programs object of study of the Faculty of Engineering that were active between 2016 and 2017.

As a result of the information processing, it was obtained that the students in the Saber 11 test reached a good rating scale and in the Saber Pro test these same students reached a regular rating scale, a phenomenon that places the latter in a position below the national average. Therefore, in front of this atypical behavior, the need to explain the causes of this phenomenon is generated, as well as to review the learning processes and the development of specific competences, with the pedagogical purpose of training more competent professionals and raising the performance in the Saber Pro tests.

Keywords: *Competences, Evaluation, Saber 11, Saber Pro, SPSS.*

Resumen

Este trabajo tiene como objetivo evaluar las competencias en lectura crítica y el pensamiento científico matemáticas y estadística de los estudiantes de último semestre de Ingeniería Financiera e Ingeniería Comercial. En este contexto, se considera la evaluación como un proceso orientador del aprendizaje, puesto que, a través de ella se logra obtener la información necesaria para identificar qué fue lo aprendido, lo no aprendido y se puedan tomar decisiones asertivas en el proceso de enseñanza y aprendizaje. Por lo anterior, en esta investigación, se realiza un seguimiento a los resultados alcanzados por los estudiantes en las Pruebas Saber 11 aplicadas por el ICFES y, posteriormente, a los resultados obtenidos por los mismos estudiantes en las Pruebas Saber Pro, pertenecientes a los programas en mención de la Universidad Libre.

Esta investigación es un estudio de diseño evaluativo, no experimental, de carácter explicativo que utiliza una metodología de complementariedad entre el método cualitativo y el cuantitativo. Como instrumento para el procesamiento de datos se empleó el software SPSS, por medio del cual se evaluaron los resultados generados en la Prueba Saber 11 y Prueba Saber Pro. La muestra fue de carácter censal conformada por 187 estudiantes universitarios pertenecientes a los dos programas objeto de estudio de la Facultad de Ingeniería que se encontraban activos entre los años 2016 y 2017.

Como resultado del procesamiento de la información, se obtuvo que los estudiantes en la Prueba Saber 11 alcanzaron una escala valorativa de bueno y en la Prueba Saber Pro estos mismos estudiantes alcanzaron una escala valorativa de regular, fenómeno que los ubica a estos últimos en una posición por debajo de la

media nacional. Por lo tanto, frente a este comportamiento atípico se genera la necesidad de explicar las causas de este fenómeno, así como también, revisar los procesos de aprendizaje y el desarrollo de las competencias específicas, con el propósito pedagógico de formar profesionales más competentes y elevar el desempeño en las pruebas Saber Pro.

Palabras clave: *Competencias, Evaluación, Saber 11, Saber Pro, SPSS.*

Introduction

The evaluation of the competences in critical reading and scientific thinking, mathematics and statistics has become a priority in the Faculty of Engineering of the Universidad Libre, reason why, from 2014 to 2018, tests were designed and applied diagnostic tests by means of which the competences in critical reading of expository and argumentative texts were evaluated in students who entered the different university programs for the first time. The results analyzed in the evaluated years, showed difficulties in inferential and critical reading in 63.63%, which determines the urgency of implementing pedagogical strategies that allow improving performance in the inferential analysis of academic texts, the development of critical thinking and students' logical reasoning.

Similarly, the activities and evaluations applied by teachers to students in the regular classroom show low results in activities such as: analysis of short sentences in physics and mathematics, poor interpretation in the application and conducting workshops, as well as, clearing up unknowns, solving problems, following instructions in disciplinary areas, applying theories for the analysis of results in laboratory practices, among others.

Therefore, the diagnosis made not only allows knowing the problematic variables, but also enables reflection on the teaching

and learning process, as well as attempts to respond to a complex situation that involves the institution, quality, evaluation and the development of relevant competencies for the performance of the future professional. According to Maldonado (2014) "evaluation is a central phase in a training process for the acquisition and development of skills. Understanding this stage is understanding that a competence is synonymous with evaluation and recognition of know-how" (p. 40).

In this sense, it is necessary to recognize the evaluation as a pedagogical action that allows to deepen and show in the results, the academic advances, as well as the degrees of difficulty and the skills not developed in the evaluated groups, with the intention of proposing the solution to the problem. According to the Dictionary of Educational Evaluation and Research (1985):

> The term evaluation has a much broader meaning than the word measure. The latter is a quantitative description of the behaviors, while the evaluation comprises both the qualitative description and the quantitative description of the behaviors and a value judgment that affects their desirability. (p. 145)

Likewise, Schuman (1967) distinguishes the evolution of the term as a social process by which value judgments are produced and evaluative research as a set of procedures for the collection and analysis of data that increases the possibility of testing rather than of affirm. Additionally, López (2014) points out that "the evaluation for learning is an integral part of the teaching and learning process since it is an essential tool to determine where students are in their learning process, where they should be, and what they must do to improve" (p. 7).

On the other hand, According to the Ministry of National Education (MNE), with the issuance of Law 1324 of 2009, a regulatory framework was established that established the parameters and criteria that govern the organization and

operation of the education quality evaluation system. In this sense, the State exams operate as control instruments for the (MNE) whose function is to inspect and monitor the results of the tests and take decisions to improve the quality of education.

There are many changes that have been generated since the evaluation process began with the Saber 11 Test applied by ICFES, not only has the structure of the question been modified, but also the addition of new booklets or modules that respond to policies of quality or particular interests of the State, according to the Development Plan of the current government. To cite a few examples, the test was extended to the third grade of elementary school, to the ninth grade of secondary school and later, to higher education with the test called Saber Pro.

The Saber Pro test, entitled mathematical and statistical scientific thinking, was one of the last modules of specific competences evaluated by ICFES and since August 2014 it was accepted as final. The results have been made public as of March 2015, confirming what academics already sensed the difficulty of students to understand, analyze and front facing real or abstract situations with scientific rigor, a phenomenon that has been evidenced in the last four years.

On the other hand, critical reading has been a challenge in higher education institutions. In this regard, Parodi (2014) points out:

> Active learning from what has been read requires from the reader a critical stance regarding the content of the text. This implies reflective thinking through which an inspection of the text is carried out and the ideas expressed in it are evaluated. In this sense, critical reading requires that the reader actively participate in the construction of the meanings of the text, and take a stance on what it says. This implies that the reader builds his own thoughts from what is said in the text and that he is able to evaluate what is said and decide whether he agrees with it or not. In this way, a critical and reflective reader, who seeks to learn from what he

> reads, must evaluate the content of the text and identify his own beliefs and positions and distinguish them from the author of the text. (p. 150-151)

Therefore, the development of skills in critical reading allows the reader to establish an open dialogue with the author of the text, from their own theoretical references, their beliefs, their values and their position in relation to what is proposed by the author. Consequently, this act of the active reader's superior thinking involves deep reflection, self-resignification and a new discursive construction.

The underlying problem in the reading of inferential and critical transcendence is a problem studied in Colombia in the last 20 years, both in public and private universities. Cisneros et al. (2010) proved that only 17% of students apply inferential reasoning as a reading comprehension strategy, compared to an argumentative expository text.

According to Parodi and Peronard (2010), understanding a text is not an easy task, since this cognitive exercise involves detecting the theme, the issues developed, the main and secondary ideas, the overall idea of the text and the author's purpose; all this aspect conditioned to the nature of the text from higher to lower complexity.

Due to the above, this research aims to evaluate through the SPSS software the competencies in critical reading and scientific thinking, mathematics and statistics, in the Saber 11 and Saber Pro Tests, 2016-2017 in students of the Commercial Engineering and Financial Engineering of the Universidad Libre. In this sense, the results of this research allow orienting the way to be followed in the short and medium term, with the purpose of offering alternative solutions to the needs of students.

Materials and Methods

Design

This research is an evaluative design study, non-experimental, of character explanatory that uses a methodology of complementarity between the qualitative and quantitative methods. From the qualitative method, the relationship between variables and efficiency levels was measured through the SPSS, performing an analysis of contingency tables that estimates the comparative relationship of the tests, through the distribution of percentages. On the other hand, from the qualitative approach the interpretation of the data was carried out, taking into account the structural and situational contexts of the problem, generating a pedagogical proposal for both programs, in order to improve the performance levels of the students in the Tests Saber.

Participants

The population sample consisted of 187 students belonging to the Universidad Libre Seccional Pereira, divided as follows: 56 participants of the Financial Engineering program and 131 participants of the Commercial Engineering program who were active between 2016 and 2017, and who were studying the programs in the daytime and at night.

Instruments

The data analysis process was carried out through the SPSS Software, with the purpose of comparing the results of the Saber Pro Test and the Saber 11 Test, achieved by students of the Commercial Engineering and Financial Engineering programs in 2016 and 2017. It is important to clarify that, although the subjects evaluated by the ICFES in the Saber 11 Test and the Saber Pro Test are different, they have in common the evaluation of critical reading skills and scientific mathematical and statistical

thinking. In the Saber 11 Test, the areas that were considered for the evaluation by the affinity with the objectives of the study were: language and mathematics, and in the Saber Pro tests, critical reading and scientific thinking, mathematics and statistics were evaluated.

In this sense, the Saber 11 Test was downloaded through the interactive ICFES platform of the Colombian Government. Subsequently, it was necessary to convert the results from quartile to percentile since both tests present a different measurement. In this sense, the national average and the national standard deviation were considered for each of the competencies evaluated in the Saber 11 and Saber Pro tests, to apply the normal distribution formula.

With the above information, in the data view tab of the SPSS statistical software the numerical information was entered in decimal values corresponding to the results presented by each student in relation to the Saber 11 Test and the Saber Pro Test. It should be clarified that; it was necessary to configure the classification of the numerical variable.

Subsequently, the report of the contingency table used to analyze the relationship of one variable as a function of another was generated, through the distribution of percentages. To obtain the contingency table, it was necessary to use the analyze function of the SPSS software in descriptive statistics and cross tables, assigning the Saber 11 rating as a row and the Saber Pro rating as a column. Next, in the boxes tab, it was necessary to activate the options observed, column and round the cell count to be able to generate the table.

Procedures

For the development of the research, the competences in critical reading and scientific mathematical and statistical thinking were evaluated in the students of the programs under

study in the Saber 11 test and the relationship with the results of the Saber Pro test in the period 2016- 2017, through SPSS analysis, and the results were analyzed in light of the theory.

Results

The results of the Saber Pro Test and Saber Test 11 of the students under study in the Financial Engineering program are presented below, with their respective evaluation on a scale of 1 to 5, where 1 is the low performance score and 5 is the highest yield performance score.

Table 1. General behavior of the Saber Pro 2016 and 2017 Test, according to the results of the Saber 11 Test of the Financial Engineering program

			QUALIFICATION SABERPRO				
			1	2	3	5	Total
QUALIFICATION SABER11	2	Count	1	1	2	0	4
		% within RATING SABER11	25,0%	25,0%	50,0%	0,0%	100,0%
	3	Count	2	15	15	15	47
		% within RATING _SABER11	4,3%	31,9%	31,9%	31,9%	100,0%
	5	Count	0	1	1	3	5
		% within RATING _SABER11	0,0%	20,0%	20,0%	60,0%	100,0%
Total		Count	3	17	18	18	56
		% within RATING _SABER11	5,4%	30,4%	32,1%	32,1%	100,0%

Table 1 shows that a total of 56 students were evaluated in the Financial Engineering program. Therefore, in category 2 of the Saber 11 Test, 4 students were found and when comparing with the Saber Pro Test, 1 student represented by 25% fell to category 1 (very low), likewise, another student corresponding 25% retained category 2 (low). On the other hand, 2 students, corresponding to 50%, rose to level 3 (regular), and no student reached category 5.

In category 3 of the Saber 11 Test, 47 students were evidenced and when comparing with the Saber Pro Test, 2 students corresponding to 4.3% passed to a lower level: category 1 (very low), 15 students represented by the 31.9% fell to category 2 (low), while 15 students, corresponding to 31.9%, retained category 3 (regular) and the remaining 31.9% represented by 15 students went up to category 5 (excellent).

Finally, in category 5 of the Saber 11 Test, 5 students were found and when comparing with the Saber Pro Test, 1 student represented by 20% fell to category 2 (low), another student corresponding to 20% fell to category 3 (regular) and 3 students belonging to 60% maintained category 5 (excellent).

Table 2. General results of the Financial Engineering Program

QUALIFICATION	1		2		3		5		Higher performance
COMPETENCIAS	%	No. Students	%	No. Students	%	No. Students	%	No. Students	
SABER PRO	5,40%	3	30,40 %	17	32,10 %	18	32,10 %	18	5
Critical reading	19,60 %	11	25,00 %	14	21,40 %	12	**33,90 %**	19	5
Scientific thought mathematical	25,00 %	14	19,60 %	11	**30,40 %**	17	25,00 %	14	3

The partial results by competencies in the Financial Engineering program demonstrated that most of the Financial Engineering students who took the Saber Pro Test between 2016 and 2017 were classified in level 3 of the Saber 11 Test.

In this sense, the competencies of the students of the program with financial emphasis demonstrate a 33.90% grade 5 corresponding to the critical reading competency. On the other hand, the scientific thinking, mathematics and statistics competence presents 30.43% located in grade 3. Therefore, the need to implement an improvement plan is exalted that allows university students to enhance their competencies in: critical

reading and mathematical scientific thinking as a fundamental basis for cognitive and metacognitive development that enables the development of heuristic, flexible and creative thinking; as well as "unveiling the counter-hegemonic ideology, the recognition of the hegemonic ideology and the identification of professional interactions" (Díaz, Bar & Ortiz, 2015).

Table 3. General behavior of the Saber Pro 2016 and 2017 Test, according to the results of the Saber 11 Test of the Commercial Engineering program

			QUALIFICATION _SABERPRO				
			1	2	3	5	Total
QUALIFICATION_ SABER 11	2	Count	5	5	4	0	14
		% within RATING _SABER11	35,7%	35,7%	28,6%	0,0%	100,0 %
	3	Count	13	41	33	13	100
		% within RATING _SABER11	13,0%	41,0%	33,0%	13,0%	100,0 %
	5	Count	4	3	3	7	17
		% within RATING _SABER11	23,5%	17,6%	17,6%	41,2%	100,0 %
Total		Count	22	49	40	20	131
		% within RATING _SABER11	16,8%	37,4%	30,5%	15,3%	100,0 %

The previous results indicate that a total of 131 students were evaluated in the Commercial Engineering program. Therefore, in category 2 of the Saber 11 Test, 14 students were located and when comparing with the Saber Pro Test, 5 students represented by 35.7% fell to category 1 (very low), likewise, 5 students corresponding to 35.7% retained category 2 (low). On the other hand, 4 students, corresponding to 28.6%, went up to level 3 (regular), and no student reached category 5.

In category 3 of the Saber 11 Test, 100 students were evidenced and when comparing with the Saber Pro Test, 13 students corresponding to 13% passed to a lower level: category 1 (very low), 41 students represented by 41% they fell to category 2 (low), while 33 students corresponding to 33% retained category 3 (regular) and the remaining 13%, representing 13 students, rose to category 5 (excellent).

Finally, in category 5 of the Saber 11 Test, 17 students were found and when comparing with the Saber Pro Test, 4 students represented by 23.5% fell to category 1 (very low), 3 students corresponding to the 17.6% fell to category 2 (bad), likewise, 3 students referring to 17.6% fell to category 3 (regular) and 7 students, represented by 20%, retained category 5 (excellent).

Table 4. General results of the Commercial Engineering Program

QUALIFICATION	1		2		3		5		Higher performance
COMPETENCIAS	%	No. Students	%	No. Students	%	No. Students	%	No. Students	
SABER PRO	16,80%	22	**37,40%**	49	30,50%	40	15,30%	20	2
Critical reading	**34,30%**	45	18,30%	24	25,20%	33	22,20%	29	1
Scientific thought mathematical	**33,60%**	44	32,80%	43	16,00%	21	17,60%	23	3

The partial results by competencies in the Commercial Engineering Program demonstrated that 34.3% in critical reading was positioned in the lowest grade with 1, as well as 33.6% corresponding to the mathematical scientific thinking competence.

Discussion

The university student, when finding himself from his academic reality with the approach of various texts (literary, informative, scientific), must have the necessary capacities that allow him to establish a clear understanding of the contents and, what is more important, build his own Insights from reflective processes. In this sense, Freire (1989) maintains that "very few students reflect on what they perceive from the text and consequently, they do not generate new ideas, lack creativity and are not builders of their own knowledge" (p. 1). Likewise, the development of reading comprehension skills is linked to knowledge and perception of the world.

Reading comprehension as a transversal axis in the training processes must be an extension of each of the subjects that the student takes through a reading plan oriented from the micro-curricula, therefore, linguistic competence acquires a fundamental role in training comprehensive of professionals. Generally, students arrive at the university with great difficulties in reading and writing, in many cases they demonstrate a literal reading. When starting their university careers, students are faced with academic demands for which no one has trained them, since neither the school nor the university undertake the task of teaching to read inferential and critical ways different academic texts.

"Reading through the curriculum is a process in which it is proposed that the teachers of each subject take on the task of teaching reading following the arguments of each area of knowledge" (Carlino, 2013, p. 370). Many of the texts that are read in school are of the expository type, that is, they contain an absolute truth about the subject at hand, they are phonological texts.

In an argumentative reading, there are different positions on a defined topic, which leads the reader to assume a position or point of view; hence, argumentative skills also trigger critical thinking skills. Therefore there is great concern in higher education centers regarding the argumentation of students based on academic learning in textual production and its relationship with the high rates of university dropouts.

In this sense, Olave, Rojas and Cisneros (2013) examine the relationship between academic dropout and difficulties in understanding and producing academic texts at university; They also refer about the problems that teachers and students encounter in topics related to reading and writing and the importance of academic literacy:

> Training in reading and writing at the university is not an easy task, to this is added that when students with previous deficiencies arrive, higher education institutions have to make a double effort: to level their skills and, from there, promote those that need to be mastered in the university environment to achieve better results in academic performance and in the fight against desertion. (Olave, Rojas and Cisneros, 2013, p. 24).

For their part, Uribe and Camargo (2011) emphasize the needs of the teaching and learning of reading and writing in the higher academic environment and the need to integrate various strategies to generate greater results in the understanding and production of academic texts. In the same way, Rojas (2014) points out that students do not have enough tools to fully understand the specialized texts that are part of their curricula. These texts are drastically far removed from the documents that are studied during basic and secondary education, with different objectives, recipients, styles, knowledge, and cognitive requirements (Rojas, 2014).

On the other hand, the development of competencies in mathematical and statistical scientific thinking is the fact of greatest interest to politicians, government officials, industrialists, technological developers, engineers, among others, in today's globalized and competitive world. In this sense, students and professionals are required to understand highly symbolic, specialized and scientific languages that are expressed in assertive, propositional, hypothetical, explanatory sentences, general principles, laws, definitions and theorems, associated with mathematical logic and quantitative statistical procedures that make it possible to measure, assess and evaluate all kinds of human processes and actions. In this regard, Pacheco and Gutiérrez (2011), refer to the scientific method and define it as "a set of steps to follow that, based on logic, mathematics and statistics, among other areas of knowledge, allows to explain phenomenological events and, when its results are used as a support for technology, control or modify nature" (p. 74).

Finally, the current era generates surprising volumes of information, in various theoretical fields and with different forms and graphic, numerical, and geometric representations that are also accompanied by arguments of character statistical and probabilistic. Therefore, it is urgent to develop logical mathematical thinking from early childhood and throughout academic life so that in professional interaction it can face numerical and logical challenges, with the purpose of capturing and understanding the information that is presented in mathematical terms, such as: graphs, diagrams or tables, by means of references to percentage increases or decreases (Cardoso & Cerecedo, 2008).

Conclusions

After the investigation, it can be concluded regarding the development of competences in critical reading and in scientific mathematical and statistical thinking that:

- If the students of the Commercial Engineering and Financial Engineering programs did not pass the results in the Saber Pro test with respect to the results, they achieved in the Saber 11 test in critical reading and in scientific thinking, mathematics and statistics, it can be inferred that, the university failed to develop superior thinking structures so that students could demonstrate their competencies in practice.

- The students were interested in achieving better results in the Saber 11 test since the entrance to the university depended on these results, on the other hand, the Saber Pro test represents only a requirement to graduate.

- According to the results obtained in the SPSS analysis, the students did not improve their academic performance in critical reading and in scientific thinking, mathematics and statistics, in relation to the Saber 11 test, in the last university semesters.

- The study shows, from the results of the evaluation carried out, information that can guide administrative decisions that impact the curriculum or guide academic intervention for the development of competencies in critical reading and in mathematical and statistical scientific thinking.

- It is suggested from the pedagogical reflection to work the PBL Problem-Based Learning method so that the student can analyze various events in the real world from statistical problems, mathematical problems and from a vision of scientific thinking, logical thinking, as well as, critical reflection, so that you can propose a viable solution to problems.

- It is necessary to form a discursive academic community to the extent that the teachers of the Commercial Engineering and Financial Engineering programs pedagogically socialize the practices and methodologies necessary so that students can approach critical reading and scientific mathematical and statistical thinking in this field of knowledge.

- Through academic literacy it is expected that teachers from their areas of specific knowledge can offer guidelines, strategies and recommendations so that students can assume scientific reading as a necessary activity for their academic performance in the program and in their future performance professional.

- It is necessary to recognize evaluation as a process linked to learning, therefore, a mathematical competence is linked to the cognitive development of being able to understand theories, concepts and to establish mathematical properties and relationships to create and do.

- Confronting the results of the SPSS analysis regarding the development of competencies in critical reading and in mathematical and statistical scientific thinking, taking as a reference the background of the diagnostic test applied by the institution between the years 2014 - 2018, and the research carried out By Cisneros, Olave & Rojas (2013) it can be concluded that the results obtained by these investigations are similar to studies carried out

in other Colombian and Latin American universities. Finally, it is urgent to work from the IEP Institutional Educational Project to impact the curriculum of these programs from the mathematical dimensions and design the strategy from competencies such as: formulate, represent and solve problems from logic and argumentation to develop scientific thinking.

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